

---

# Lessons learned from pilot site implementation of an ambulatory electronic health record

Cliff Fullerton, MD, Phil Aponte, MD, Robert Hopkins III, MPH, PhD, David Bragg, MD, and David J. Ballard, MD, MSPH, PhD

---

As ambulatory care practices face increasing pressure to implement electronic health records (EHRs), there is a growing need to determine the essential elements of a successful implementation strategy. HealthTexas Provider Network is in the process of implementing an EHR system comprising GE Centricity Physician Office—EMR 2005, Clinical Content Consultants (now part of GE), and Kryptiq Secure Messaging throughout all 88 practices in the Dallas–Fort Worth area and is hoping to extend the system to other practices affiliated with Baylor Health Care System as well. We describe the preimplementation clinical process redesign and quality improvement training that has been conducted networkwide in preparation for the introduction of the EHR, as well as the specific steps taken to prepare and train clinic staff for the integration of the EHR into daily workflows. The first pilot site, Family Medical Center at North Garland, implemented the system in May 2006. Based on both the

positive aspects of this experience and the challenges we encountered, we identified 20 essential elements for successful implementation in the areas of site selection, implementation strategy, staff education and preparation, team project management, content, hardware and software, and workflow process. Broadly, we determined that 1) a pilot site's understanding of and willingness to work within the fluid nature of the implementation process during what is essentially a testing phase is a key ingredient in achieving success at the pilot site and in improving the process for later sites; 2) input from and representation of viewpoints of all types of EHR users during preimplementation decision making enables customization of the system and sufficient preplanning to ensure minimal workflow disruptions during and after implementation; and 3) a high level of technical and training support during the early days of implementation is invaluable.

---

A recent systematic review of the literature revealed areas in which evidence of the impact of health information technology on quality, efficiency, and cost of medical care is lacking or sparse. This Agency for Healthcare Research and Quality–funded RAND study found that a substantial proportion of existing studies focus on four academic medical centers using “homegrown,” tailored electronic health record (EHR) systems and that little information is available about the effectiveness and impact of commercially available systems, particularly in the ambulatory care setting (1). Evidence becomes even more sparse when small ambulatory care practices (those with 10 or fewer physicians) are considered. An additional topic that has received little attention in the research literature is how to achieve an implementation process that predisposes the EHR to success.

The importance of the implementation process and the need to involve clinicians and other staff who will use the EHR throughout the planning and preparation stages has been demonstrated—most notably at Cedars-Sinai Medical Center (2). Experience has also shown the need for adequate technical support, both during and after initial implementation, and the importance of collaboration between representatives from the EHR vendor and the clinical site implementing the EHR to understand the site's workflows and determine the best use of EHR within these workflows (3). Other practices and organizations,

however, seem to bypass such problems and achieve quality, efficiency, and financial benefits. The question of what makes the difference has not been fully explored. Miller et al uncovered part of the answer by interviewing a group of physician EHR users (4). They found that the physicians and practices that were saving time and money were those that had invested the effort during implementation in creating templates for documentation, entering past patient data, setting up interfaces with other data sources such as laboratories, developing on-site technical support resources, and reorganizing their workflow to incorporate the EHR. The success that can be achieved by incorporating these steps into the implementation process is reported by Mercy Medical Group in St. Louis (5).

HealthTexas Provider Network (HTPN) is the ambulatory care subsidiary of Baylor Health Care System (BHCS)—a not-for-profit integrated health care delivery system serving patients throughout North Texas and beyond. HTPN comprises 88 primary care, specialty care, and senior health centers, with >370

---

From the Family Medical Center at North Garland, HealthTexas Provider Network, Garland, Texas (Fullerton, Bragg); and Institute for Health Care Research and Improvement, Baylor Health Care System, Dallas, Texas (Aponte, Hopkins, Ballard).

**Corresponding author:** David J. Ballard, MD, MSPH, PhD, Institute for Health Care Research and Improvement, 8080 North Central Expressway, Suite 500, Dallas, Texas 75206 (e-mail: dj.ballard@BaylorHealth.edu).

Activity	Jan 2006	Feb 2006	Mar 2006	Apr 2006	May 2006	Jun 2006	Jul 2006	Aug 2006	Sep 2006	Oct-Dec 2006	Jan-Jun 2007	Jul-Dec 2007	Jan-Jun 2008	Jul-Dec 2008
Key decisions complete														
Define and refine enterprise content needs by specialty														
Define and refine enterprise workflow needs														
Define and refine enterprise form/reporting customization requirement														
Build enterprise test server														
Enterprise testing														
First pilot site														
Second pilot site														
Third pilot site														
Fourth pilot site														
"Early adopter" practices														
"Early/mid adopter" practices														
"Mid/late adopter" practices														
"Late adopter" practices														

**Figure 1.** Roll-out schedule for implementation of the HealthTexas Provider Network ambulatory electronic health record.

physicians, and cares for ~850,000 patients annually. HTPN is implementing a networkwide ambulatory electronic health record (AEHR) and aims to achieve total implementation of the system by December 2008. The decision to move as an organization from traditional paper-based records to an electronic system was based in part on the positive experience of one HTPN practice, Family Medical Center at North Garland, which has been using an AEHR since 1997.

Following the decision to implement an AEHR throughout HTPN, a variety of commercially available AEHR systems were investigated. The package identified as best meeting HTPN's needs and chosen for implementation, referred to as the "Enterprise Model," comprises GE Centricity Physician Office-EMR 2005; Clinical Content Consultants (CCC), which was acquired by GE in 2006; Biscom faxing; and Kryptiq Secure Messaging. Although indistinguishable from the user's view, each component contributes unique functionalities to the AEHR: Centricity Physician Office (formerly Logician) provides the basic platform through which clinical information is integrated; CCC incorporates clinical content and clinical decision support; and Kryptiq includes Docutrack, which provides integrated scanning, and Secure Messaging, which ensures security for both physician-patient and physician-physician e-mails, including communication with clinicians who do not have an AEHR. Another feature of Kryptiq planned for future implementation is the CareCatalyst patient portal. This feature will allow patients to have interaction with their chart, such as posting home blood pressure monitoring results or newly added medications from other providers. This patient-generated information will be incorporated into the chart only after it is accepted or edited by the physician.

Together these components provide an AEHR that is essentially paperless; includes integrated clinical decision support, faxing, and scanning; facilitates secure messaging between physicians and/or between physicians and patients; allows remote access and wireless connection; provides evaluation and

management coding assistance; and facilitates development of automated electronic orders cycles. An orders cycle might be thought of as a "loop" of care, whereby a test is ordered, scheduled, performed, and the results communicated to the provider and then to the patient. A highly functional integrated voice recognition system is also available, although not part of the standard package. The single patient record ensures that any HTPN physician who sees a patient will have access to all of the patient's current data. This provides quality-of-care benefits beyond those a clinical decision support system alone can provide in terms of drug-drug interaction checking, drug allergy checking, and protocol adherence, as it ensures continuity and prevents gaps in care and wasteful redundancy. The Enterprise Model offers multiple opportunities to improve quality of care and patient safety: errors of omission should be reduced by automating and standardizing processes and subprocesses of care through order sets, protocols, and care maps. The single patient record and secure communication features should improve effectiveness of professional communication and ensure that appropriate patient information is available at the point of care. The system provides an improved means of error reporting and allows individual practice sites to track their quality and safety performance, facilitating plan-do-study-act quality improvement cycles.

#### AEHR DEPLOYMENT AND IMPLEMENTATION PLAN

Given the impracticality of implementing the AEHR in all 88 HTPN practices simultaneously, a staggered roll-out schedule was developed. All practices were characterized as "pilot," "early," "mid," or "late" adopters, according to their technical readiness and willingness to adopt the AEHR, and were assigned to an implementation period accordingly (*Figure 1*). Three aspects of technical readiness were considered in making these assignments: the connectivity of the clinic with the main BHCS network, the network infrastructure within the clinic, and the existing equipment within the clinic. With regard to network

connectivity, all clinics fell into one of two categories: those on or close to BHCS hospital campuses and thus connected to the main network via high-speed fiber-optic networks and those connected via bundled T1 lines. Preference was given to clinics with fiber-optic network connections in making the assignments to implementation periods. The network infrastructure within clinics took into account the presence or absence of wireless networks and network ports already available in the examination rooms, and the existing equipment assessment determined the number of existing computers that were capable of running the Enterprise Model. The planned roll-out included implementation at four pilot sites over a 5-month period.

The preparation for and process of implementation, when examined both at the organizational and individual clinic levels, aligns with the Toyota Production System (TPS), which has been showing success as a model for quality improvement in health care (6–8). The essence of TPS is contained in the four organizing principles, or rules-in-use, defined by Spear and Bowen (9):

1. All work activity shall be highly specified as to content, sequence, timing, location, and expected outcome.
2. Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses.
3. The pathway for every product and service must be simple and direct, with no forks or loops.
4. Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the appropriate level of the organization closest to the work.

Specifically, the preparation for AEHR implementation aligns closely with rule 1, in that prior to implementation, physicians and staff at each clinic examine and define their workflows and processes, mapping these out and, when necessary, redesigning them to integrate with the applications and functions within the AEHR system. Much of this work also aligns with rule 3, as the process of workflow redesign offers the opportunity to streamline inefficient and unnecessarily complex workflows. Alignment with rule 4 is demonstrated by the inclusion of clinical decision support, physician reminders, and similar tools to support the practice of evidence-based medicine in the Enterprise Model. In addition to ensuring that the clinical content of the AEHR supports the practice of evidence-based medicine, HTPN has laid much of the groundwork by implementing quality improvement initiatives targeting compliance with evidence-based practices while operating on predominantly paper-based systems.

The tools supporting the practice of evidence-based medicine also reflect the “autonomation” aspect of TPS in the AEHR implementation. Autonomation is the addition of human intelligence to the automation of work and is designed to prevent errors of omission and commission and to stop the process when an error is detected. The incorporation of evidence-based practices in the workflow through the AEHR builds many error-prevention steps into the processes of care by standardizing care, preventing unnecessary variation, and including tools such as physician reminders of clinical preventive services (CPS) that

patients are eligible for but have not received. In addition, error-detection tools such as drug-drug interaction and drug allergy checking have been included in the Enterprise Model.

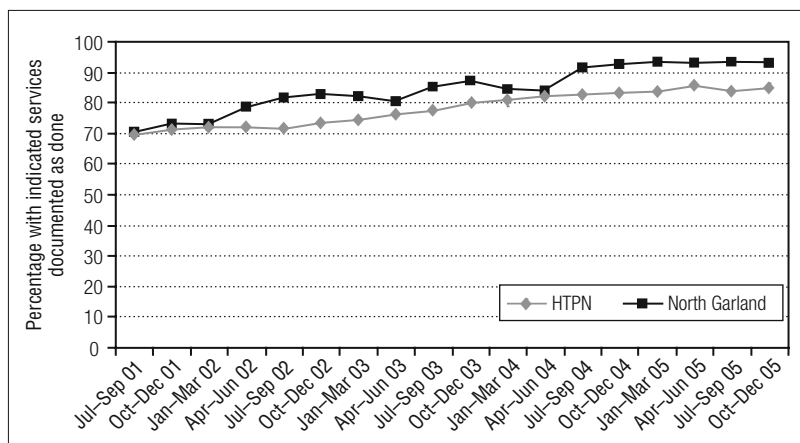
Finally, TPS involves the alignment of workflow and processes with the expectations and requirements of those using the system. Although success in this regard will be evident only after the AEHR is fully implemented across HTPN, every effort was made during the planning phase to obtain input from all users about the content of the Enterprise Model. This effort continues in the implementation stage, as clinicians and office staff are directly involved in defining the office workflows and working to have these incorporated in the AEHR content as it is implemented at each clinic.

## **PRE-AEHR IMPLEMENTATION PROCESS REDESIGN AND QUALITY IMPROVEMENT TRAINING**

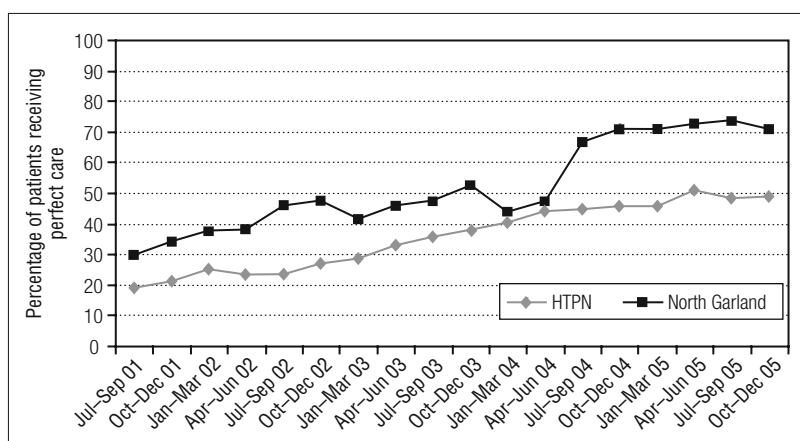
The importance of preparing adequately and approaching the introduction of information technology to health care settings as an organizational change as opposed to a purely technical implementation has been amply demonstrated by previous organizations’ experiences following the introduction of tools such as EHRs and computerized physician order entry (10). Inadequate attention to process redesign and process improvement training prior to implementation—resulting in “systems integration failure” and “human machine interface flaws”—can lead to decreased quality of care and poorer patient outcomes after technology implementation (11, 12). Information technology cannot be expected to achieve quality improvement when its patterns of use have not been tailored to the workers and their environment (10).

In April 1999, HTPN formed a Quality Committee, which instituted a preventive health services initiative to promote CPS delivery in HTPN practices. With a focus on 11 services endorsed by the US Clinical Preventive Services Task Force (13), a data collection protocol was developed based on a tool provided by colleagues at the Mayo Clinic (14). Baseline data for the networkwide initiative were established through a 1-year retrospective chart review in June 2000. Thereafter, data were collected quarterly by trained nurse abstractors using a chart audit tool created in Microsoft Access. For each physician, 30 randomly selected charts were audited each quarter, until July 2005 when the audit became semiannual. From June 2000 to July 2001, a service was counted as delivered if documented as 1) done or recommended by the physician; 2) reported by the patient as done elsewhere; or 3) declined by the patient/unable to perform. Beginning in July 2001, the distinction between “recommended” and “done” was made, with both being reported for each physician. Physician performance was calculated as the percentage of eligible patients to whom a service was delivered.

From 2000 to 2005, several quality improvement initiatives targeting CPS delivery were undertaken within HTPN. These included the introduction of the adult CPS medical record form, which incorporated a flow sheet for CPS delivery and documented more than 20 Health Plan Employer Data and Information Set (HEDIS) CPS indicators, and feedback of individual physician performance on CPS delivery, shown



**Figure 2.** Overall clinical preventive services delivery at Family Medical Center at North Garland vs remaining HealthTexas Provider Network practices, July 2001 to December 2005. Only clinical preventive services documented as “done”—as opposed to “done” or “recommended”—were considered to have been delivered.



**Figure 3.** Delivery of “perfect care” (the proportion of patients who received all clinical preventive services for which they were eligible) at Family Medical Center at North Garland vs the remaining HealthTexas Provider Network practices, July 2001 to December 2005.

relative to average practice performance and average HTPN performance.

In July 2001, when the distinction between “done” and “recommended” was first made, overall CPS delivery in HTPN was 70%. That percentage improved to 86% in 2005. When North Garland, the only HTPN practice with a history of using an AEHR, was compared with the rest of HTPN, its performance on CPS delivery—examined as the percentage of recommended CPS delivered to patients—was initially similar to HTPN average performance, but then it improved more rapidly and reached a higher level of CPS delivery than the remaining HTPN practices (*Figure 2*). A similar pattern was seen when CPS delivery was examined in terms of “perfect care,” i.e., a composite score indicating the proportion of patients who received all the CPS for which they were eligible (*Figure 3*). This suggests that some aspects of the AEHR, such as automatic CPS reminders and easier access to patients’ records to determine CPS eligibility and history, can enhance and accelerate the effectiveness of quality initiatives.

Related to the role of AEHR in supporting quality improvement initiatives is the training in quality improvement

methods and evaluations HTPN physicians and staff have received through the “Accelerating Best Care at Baylor” classes.

In 2001, 25 BHCS physicians and quality improvement leaders, including several HTPN physicians, completed the Intermountain Healthcare Mini-Advanced Training Program in Health Care Delivery Improvement (15), learning the skills and techniques necessary for developing, leading, and evaluating rapid-cycle continuous quality improvement initiatives. To make the benefits of this training more widely available to BHCS and HTPN employees, BHCS worked with the leaders of the Intermountain Healthcare program to develop a local version, colloquially known as “ABC Baylor.” The course focuses on health care quality improvement, including theory and techniques of rapid-cycle quality improvement, outcomes management, and staff development. It is designed to facilitate the development of skills needed by physicians, administrators, nurse managers, and others to actively lead, participate in, and direct quality improvement efforts. The course consists of three lecture-style sessions, taught by the BHCS and HTPN graduates of the Intermountain Healthcare program, at the end of which each participant selects, designs, and completes a quality improvement project within his or her work environment. At the fourth class session, participants present the results of their projects.

Since ABC Baylor was first offered in 2004, 85 HTPN physicians and 20 nursing and administrative staff have completed the program. Many of the quality improvement projects they conducted and presented for ABC Baylor addressed areas of ambulatory care for which functionalities in the AEHR could simplify or enhance the quality improvement process. These projects included the following: improving primary care follow-up after an emergency department visit; simplifying, standardizing, and tracking the referral process for tests performed outside of the primary care environment (such as magnetic resonance imaging and mammography); improving delivery of adult and pediatric CPS; improving the management of hypertension, diabetes, and asthma; increasing the efficiency of the medication refill process; standardizing the process for outside correspondence to ensure that all relevant information is included in the patient’s chart; and introducing protocols for the diagnosis and treatment of common conditions such as strep throat.

Furthermore, the combination of the quality improvement skills that clinicians and other staff have acquired through the Intermountain Healthcare and ABC Baylor programs and the advanced functionalities incorporated in the Enterprise Model AEHR will allow individual physicians and clinics to conduct small-scale population management quality initiatives similar to the networkwide CPS initiative targeting other processes of care and conditions. For example, using the AEHR, a physician

Activity	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Kickoff															
Schedule clinic training															
Current state workflow															
Weekly meetings (future state)															
Develop preload strategy															
Implementation team training															
Preload training															
Windows proficiency															
Chart cleanup															
Practice management account cleanup															
Demographic dump (Demo IF LIVE)															
Lab results dump (Lab IF LIVE)															
Preload data															
Centricity training															
Schedule dump (Sched IF LIVE)															
Workflow training and simulation															
Go live															

**Figure 4.** Sample breakdown of planned implementation activities and timeline for a single HealthTexas Provider Network practice.

could run monthly reports to determine how many of his or her diabetes patients had a hemoglobin A<sub>1c</sub> test within the last 6 months and then design and implement an improvement program—using the plan-do-study-act approach taught in ABC Baylor—to improve performance on this measure.

### PRE-AEHR ENTERPRISE MODEL TRAINING

An AEHR training course was developed by HTPN in-house trainers in conjunction with GE consultants. This hands-on course is taught on-site at each clinic using a “traveling training lab” consisting of 10 laptops loaded with all components of the Enterprise Model. Training is provided at various times over a 2-week period prior to AEHR implementation to enable all clinical and administrative staff to complete the entire course without seriously disrupting the office workflow. The original training plan called for all front office/administrative staff to complete 4 hours of training on the relevant applications in the Enterprise Model and for all physicians and clinical staff to complete 8 hours. At the early pilot sites, the training has been conducted jointly by GE consultants and HTPN trainers. During the later phases of AEHR roll-out, the HTPN team will conduct the training independently. In addition to the pre-AEHR implementation training, each user is provided with a manual containing step-by-step instructions for all applications, and the training team and other members of the HTPN AEHR implementation team are on hand at all times during the first week of implementation (and, to a lesser extent, during the second week of implementation) to answer questions and troubleshoot problems. It is recommended that the clinics reduce their patient load by 50% during the first week of implementation and by 20% during the second week of implementation to allow time for staff to gain familiarity with the system. The preparatory process each clinic must go through prior to implementation is shown in *Figure 4*.

In May 2006, implementation at Family Medical Center at North Garland, the first pilot site, took place. We report both the lessons learned through this experience and the resulting alterations in the implementation plan. This process of evaluating each clinic implementation and applying the knowledge gained through the experience to the implementation plan for future sites will continue throughout the deployment process—following the plan-do-study-act rapid-cycle improvement process taught in ABC Baylor. We similarly monitor the content and clinical decision support incorporated in the AEHR, revising, updating, and adjusting these features as needs are identified.

### THE NORTH GARLAND EXPERIENCE

Family Medical Center at North Garland was chosen as the first pilot site, as the transition to an AEHR was made there in 1997. The AEHR system in use was Logician 5.6, which was the precursor to the Enterprise Model and was similar to the latter in many respects. The Logician system was used primarily for documenting patient notes and writing prescriptions, with some clinical decision support in the form of CPS and diabetes process of care reminders and with external interfaces only for laboratory and patient demographic data. Although the Logician system included an orders module, that module was not in use at North Garland. The Enterprise Model adds an order entry module for documentation of services that have been or need to be provided to a patient and communication with office staff regarding these services; the capability of faxing information to the pharmacy or other providers from within the AEHR; secure messaging between providers and with patients; more robust clinical content and clinical decision support for several chronic diseases in the form of the CCC forms; and an interface with the scheduling system, making it quicker for the physician to see who the next patient is and pull up the appropriate chart immediately. The physicians’ and office staffs’ familiarity with the process of using an AEHR made North

Garland the logical choice for the first implementation of the Enterprise Model within HTPN.

Since a related GE AEHR system was already in place, the North Garland implementation of the Enterprise Model was conducted as a system upgrade. No major technical difficulties were anticipated: several other GE customers had been contacted about upgrading their systems and had reported no problems, and North Garland had completed several small upgrades during the 9 years of AEHR use without encountering any problems. Unfortunately, after approximately 3 hours of being on the upgraded system, the server crashed and the AEHR was down for the remainder of the first day.

Because all the practice's patient records were electronic, the system failure left the physicians and physician extenders with an almost full case load (it had been reduced by only two to four patients per provider per session for the transition) and no complete records for these patients. In addition, there was disruption of the work processes normally handled through the AEHR, such as test ordering, patient reminders, and referrals to specialists. North Garland operated on a paper-based system for most of the first day, an eventuality that had not been expected. The system failure was linked to some potential issues with the upgrade process to the Enterprise Model of North Garland's AEHR, which were thought to contribute to the software's instability. As a result, the database was rebuilt overnight and a clean version of the Enterprise Model software was installed, which improved the situation on the second day. Over the next 3 days, the AEHR system had occasional slowdowns with multisecond screen flips and intermittent outages. When the problems had not resolved by the end of the fourth day, the AEHR platform was changed from an IBM UNIX server to a Microsoft Windows 2003 server. This transition necessitated some changes in hardware, reinstallation of the AEHR software, and migration of the database, but it achieved the goal of a smoothly running system. Since the change was made, only a few minor software errors and infrequent intermittent slowdowns have occurred, and the clinic has been able to resume its usual workflow and patient load. The server will, however, have to be changed once more because the Windows 2003 server cannot handle the user load necessary for the AEHR to run efficiently across all HTPN clinics.

## LESSONS LEARNED

Based on the experience at North Garland, we identified a number of factors that are important for successful AEHR implementation.

### Site selection

1. All pilot sites should understand that being a pilot site requires flexibility on timelines and functionality.
2. A site that already has an AEHR in place has both a different culture with regard to technology use and different challenges in creating a backup system during implementation. Such a site might not be a good choice as a pilot in a situation where most sites are moving from paper-based to AEHR for the first time, but it does have the advantage of providing the opportunity to quickly evaluate, identify, and

resolve any areas in which improvement can be achieved, as the greater familiarity with and dependence on the AEHR may result in more intense use of all the functionalities during the early days of implementation when the implementation team is on hand.

### Implementation strategy

3. Because the transition to the AEHR may not run as smoothly as hoped, a detailed plan for addressing anything from minor glitches to the worst-case scenario should be developed prior to the start of implementation and communicated to all providers and staff at the implementation site. At North Garland, the use of an established downtime policy when the system failed was instrumental in the clinic's remaining operational on the first day of implementation.
4. Adequate technical support must be available during the transition period, and providers and staff should know how to access it when needed. Ideally, most of this support should be available through internal organizational resources, both because these staff are more familiar with the work environment and related needs and because they can probably respond more quickly to an urgent request for technical support than the vendor's technical support staff.
5. A strategy needs to be developed for internal clinic communications. A standardized communication process should be in place, centralized around the AEHR implementation clinic coordinator.
6. Every individual on the project should be aware of the policies and procedures that underlie the decisions made at the organizational level regarding the AEHR and its implementation. A formalized orientation process should be developed for new members joining the project.
7. Resources need to be committed and available at a moment's notice when the system goes live.

### Staff education and preparation

8. Workflows and preimplementation training should enable the staff to use the AEHR without intense support from the implementation team after the initial implementation has been completed.
9. The HTPN AEHR Committee may need to enforce the recommended standards for training and preparation to reduce the need for on-site training during and after implementation.
10. Based on the experience at North Garland, additional training is needed on the use of the application's CCC forms—used for documenting medications, immunizations, computerized order entry, and a variety of other tasks. The training schedule has therefore been changed to require 10 hours each for the physicians and other clinical staff, 4 hours of which will be devoted to the CCC forms. At North Garland, clinicians had only 4 hours of training overall.

### Team project management

11. Having a single person act as a liaison between the HTPN AEHR team and the clinic undergoing implementation

helps these two entities communicate effectively. This implementation coordinator should know and manage the details of the implementation and should be the main contact with the clinic, communicating status and milestones, resolving issues, and contacting responsible parties. That all communication must occur through the implementation coordinator should be clearly conveyed to all involved and enforced throughout the preparation and implementation period.

12. During the decision-making process, at both the organizational and the individual clinic levels, as many people as possible should be involved, representing the views of physicians, nursing staff, administrative/financial staff, and all others who will use various functions in the AEHR regularly. The implementation and content teams should seek input from and work to obtain buy-in from all appropriate users so that the final decisions made are supported by clinic staff. Individual clinics should work to ensure buy-in of all clinicians and office staff.

### Content

13. There is a tradeoff between complexity and additional content in the AEHR functionalities, particularly in clinical decision support applications. While it is important that the AEHR applications not intimidate a first-time user, it is also important to remember that as users become more familiar with the system, they will learn and come to appreciate the advanced options and functionalities that might have appeared unnecessary at first.
14. Ideally, the medication dosages and instructions incorporated in the AEHR content should be reviewed by independent experts to ensure that prescription errors are not programmed into the system. Users are asked to report any potential mistakes or ambiguities they identify in daily use after implementation, providing ongoing “checks and balances” of the system.
15. Charge capture is too complex and involved to be incorporated during the initial AEHR implementation. Integration of these functions can follow once the AEHR is running smoothly and the practice has adjusted to its use.

### Hardware and software

16. The project scope needs to be actively managed. Greater dissemination of the risks and rewards that accompany the addition of more items or goals to the initial implementation can help determine priorities and ensure all individuals’ time is appropriately spent and not wasted on relatively unimportant items.
17. An appropriate platform for the anticipated user demand must be chosen for the AEHR system. Particular attention was paid to this requirement during the initial planning and decision-making phases of the HTPN AEHR initiative, as the system is being implemented throughout this large ambulatory care network. Ideally, actual usage should be simulated on the chosen platform prior to implementation, but load testing is not typically performed because of the prohibitive cost.

18. An interface engine, while not essential for initial implementation, is necessary to maximize the integration of information from the AEHR, the billing system, and other systems, such as those in the laboratory.

### Workflow process

19. Clinic providers and staff need to decide among themselves on the workflow they will follow for each process conducted through the AEHR. These decisions need to be based on input from all individuals involved. A step requiring the clinic to sign off on the workflow incorporated in the AEHR system prior to implementation should be included in the implementation process. Finally, it needs to be clearly communicated to all involved that although the HTPN AEHR implementation team is there to provide assistance and guidance, the *clinic* implementation team must be responsible for final decisions regarding workflow.
20. A clear management structure and plan for knowledge transfer is essential. Specifically, an integrated communications plan for the various teams involved in AEHR implementation and use, and an understanding of the interdependency of the teams, is needed. Additionally, each group or team should identify a person who is responsible for ensuring the resolution of all issues falling within that group’s sphere.

### CONCLUSIONS

Completing the implementation of the Enterprise Model at the first pilot site was an important step in achieving the goal of AEHR implementation across HTPN. The promise of information technology has been a long time coming to health care, particularly in the ambulatory care setting, and it is exciting to see its integration into the daily practice of medicine. While this first pilot implementation was not entirely without problems, it was a success overall, and we remain on track for the networkwide roll-out. As any good pilot project should, our experience at North Garland highlighted aspects of the implementation process that worked well and others that need improvement. We will be applying these lessons learned to the remaining pilot sites and networkwide AEHR roll-out within HTPN, and other organizations considering introducing an AEHR can benefit from our experience.

Given that most problems in the implementation process are likely to be encountered early on in the roll-out, careful selection of pilot sites is critical. A good pilot site is one where the staff are enthusiastic about the introduction of the AEHR, are understanding of the “fluidity” of the implementation process during what can be at times a testing phase, and are willing to sacrifice some ease of the implementation process for the sake of improving it for future sites. We were extremely fortunate in having a site like North Garland where all the staff not only were enthusiastic about AEHR introduction but also were familiar with a similar system and were willing to work with the HTPN AEHR implementation team to solve the problems that were encountered during the early days of implementation. In retrospect, since North Garland was the only HTPN practice already using an AEHR prior to this networkwide initiative, it could

be argued that a more typical practice would have been a more appropriate pilot site. Its suitability in other respects, however, made it a good choice, and the majority of lessons learned here are applicable to the wider HTPN environment.

A second issue we identified as critical to successful implementation is the involvement of as many AEHR users as possible in the content and implementation decisions, at both the organizational and individual clinic levels. This involvement, and the resulting incorporation of the input in the decision-making process, is important in obtaining the buy-in of all users; an AEHR can, after all, only be as useful as its users allow it to be. Achieving the balance between representing all relevant points of view and putting together a team structure that is sufficiently unencumbered to reach decisions can be difficult. Questionnaires and broader group meetings can be useful in obtaining input from a wider range of individuals.

Finally, having plenty of on-site support, including technical and training support, ready to address problems immediately is essential during the first week of implementation. This, fortunately, was a lesson learned the right way: because a high level of support was on hand, any difficulties that arose—from users struggling to find an application in an unfamiliar system to the entire system going down temporarily—were dealt with in a timely manner. In the first few days of transition to an AEHR system, particularly at a site that falls early in the implementation roll-out, there is no such thing as too much help.

The HTPN AEHR roll-out is proceeding essentially as planned, with the second pilot site following North Garland in July 2006. Based on our first experience, we have made some changes to the implementation process, such as extending the user training by 2 hours to allow more thorough instruction on use of the CCC forms, and we expect each implementation to be increasingly smooth as our team gains experience and the process is streamlined.

## Acknowledgments

The authors thank Basit Chaudhry, MD, for reviewing our plan for evaluating the impact of the AEHR and providing suggestions of important points to discuss in a “lessons learned”

article, and Briget da Graca, MS, for assistance in writing this article.

1. Chaudhry B, Wang J, Wu S, Maglione M, Mojica W, Roth E, Morton SC, Shekelle PG. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Ann Intern Med* 2006;144(10):742–752.
2. Connolly C. Cedars-Sinai doctors cling to pen and paper. *Washington Post*, March 21, 2005:A01.
3. Baron RJ, Fabens EL, Schiffman M, Wolf E. Electronic health records: just around the corner? Or over the cliff? *Ann Intern Med* 2005;143(3):222–226.
4. Miller RH, Sim I, Newman J. *Electronic Medical Records: Lessons Learned from Small Physician Practices*. Oakland, CA: California HealthCare Foundation, 2003.
5. Faron M, Hale T, Jesberg L. The pitfalls of introducing electronic medical records. *Ann Intern Med* 2006;144(3):220.
6. Thompson DN, Wolf GA, Spear SJ. Driving improvement in patient care: lessons from Toyota. *J Nurs Adm* 2003;33(11):585–595.
7. Spear SJ. Fixing health care from the inside, today. *Harv Bus Rev* 2005; 83(9):78–91, 158.
8. Jimmerson C, Weber D, Sobek DK II. Reducing waste and errors: piloting lean principles at Intermountain Healthcare. *Jt Comm J Qual Patient Saf* 2005;31(5):249–257.
9. Spear S, Bowen HK. Decoding the DNA of the Toyota production system. *Harv Bus Rev* 1999;77(5):96–106.
10. Wears RL, Berg M. Computer technology and clinical work: still waiting for Godot. *JAMA* 2005;293(10):1261–1263.
11. Koppel R, Metlay JP, Cohen A, Abaluck B, Localio AR, Kimmel SE, Strom BL. Role of computerized physician order entry systems in facilitating medication errors. *JAMA* 2005;293(10):1197–1203.
12. Han YY, Carcillo JA, Venkataraman ST, Clark RS, Watson RS, Nguyen TC, Bayir H, Orr RA. Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. *Pediatrics* 2005;116(6):1506–1512. Erratum in *Pediatrics* 2006;117(2):594.
13. US Preventive Services Task Force. *Guide to Clinical Preventive Services*. Available at <http://www.ahrq.gov/clinic/cps3dix.htm>; accessed February 27, 2006.
14. Chaudhry R, Kottke TE, Naessens JM, Johnson TJ, Nyman MA, Cornelius LA, Petersen JD. Busy physicians and preventive services for adults. *Mayo Clin Proc* 2000;75(2):156–162.
15. Intermountain Healthcare. Mini-Advanced Training Program in Health Care Delivery Improvement. Available at <http://www.intermountain-healthcare.org/xp/public/institute/education/miniapt/>; accessed July 8, 2006.